ICFO

SEMINAR: From Relativistic Independence and Refined Tsirelson Bounds to Information Gain in Quantum Algorithms

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15:00 to 16:00
Seminar Room

How does the correlation between two incompatible observables in one laboratory limit the Bell violation that can be observed with a distant partner? I will approach this question through relativistic independence, a postulated principle arguing that local uncertainty relations are independent of the measurement chosen by a spacelike-separated observer [1]. Combined with generalized uncertainty relations, this principle recovers the TLM bound and yields tighter inequalities that depend on local correlations. I will describe how we tested one such bound using sequential and joint weak measurements to estimate both its local and nonlocal terms from the same ensemble of entangled photon pairs [2]. I will also discuss refined Tsirelson bounds for multipartite Bell inequalities [3], related Leggett-Garg-type bounds for temporal correlations [4], and the use of correlation minor norms to detect bipartite and multipartite entanglement [5,6].

These results led us to ask whether uncertainty and noncommutativity could also explain how much a quantum algorithm learns about a function accessed through a unitary oracle. For a given number of queries, we quantify what the algorithm learns by the mutual information between its measurement outcome and the unknown property of interest. I will show how coherence enters a lower bound on this information and how basis-dependent discord quantifies the gap between the Holevo bound and the information extracted by a particular measurement [7]. I will conclude with an application to Hamiltonian learning. By choosing the probe state, evolution time and measurement basis to maximize the expected information gain at each step, we reached the target confidence in fewer measurement rounds in simulations than with the best fixed settings we tested [8].

Hosted by: Prof. Dr. Antonio Acin